Social Networks in Water Governance and Climate Adaptation in Kenya

Grace W. Ngaruiya, Jürgen Scheffran and Liang Lang

Abstract In many sub-Saharan countries, studies indicate that water scarcity is caused by institutional and political factors. However, despite implementation of a decentralized and integrated approach in water governance, additional water stress from climate-related impacts now threaten to fuel water insecurity. Borrowing from social network theory, this chapter seeks to investigate how synergy among water governance actors influences adaptation status in rural Kenya. Network data from Loitokitok district in southern Kenya is collected using the saturation sampling method and analyzed for density, structural holes, and suitable brokers. Results indicate that rural water security is augmented mainly by individual rain water harvest, effective irrigation techniques, community-based water-point protection, and intermittent capacity building. However, the integrated governance strategy fails to aid interconnective and coordinative actions among actors thus hindering spread of adaptation strategies to the wider community and results in independent implementation of water conservation measures. Consequently, we call for deliberate linkage among local stakeholders to upscale adaptation measures and enhance water security in Kenya.

Keywords Climate adaptation · Decentralization · Integrated water management · Social networks · Structural holes · Kenya

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W. Leal Filho and V. Sümer (eds.), *Sustainable Water Use and Management*, Green Energy and Technology, DOI 10.1007/978-3-319-12394-3_8

1 Introduction

Water is a natural resource whose supply wholly depends on the hydrological cycle and proper management of natural environments. It is often multifunctional and heterogeneous in nature as provision of sufficient water of adequate quality caters for human well-being and sustains biodiversity (Millennium Ecosystem Assessment 2005). A country that manages to maintain such a self-sufficient situation is deemed to have attained water security. However, Kenya is far from being water secure and is considered as a water-scarce country with less than 647 m^3 of water available per capita compared with the international benchmark of 1,000 m^3 per capita (Government of Kenya 2009b). Many reasons are forwarded to explain this scarcity including: First, arid and semiarid lands (ASAL) constitute about 80 % of the total Kenyan land area (Mutunga 2001) causing a natural shortage of water. Second, climate change impacts evidenced by recurrent drought episodes (Altmann et al. 2002) have dried up many water bodies and lowered the water table. Third, widespread deforestation of most watersheds (Wamalwa 2009) and overgrazing have interfered with microclimates and precipitation patterns. Finally, poor land management and lack of political-will to fund water infrastructure expansion have resulted in haphazard subdivision of land with subsequent negative impacts on water availability. Such diverse issues confirm findings from water security studies that indicate water scarcity in Africa is not only caused by a physical shortage of water but also mainly by institutional and political factors (UNEP and WRC 2008; Ward and Michelsen 2002). Interestingly, the cause for alarm is not only about poor water availability but also about social cohesion since researchers predict increased risk of conflicts due to water competition between social groups (farmers and nomadic herders), economic sectors, and administrative units in arid and semiarid regions of Africa (Carius 2009; Schilling et al. 2012).

To combat water scarcity, many efforts have been directed at diverse water management activities that are collectively termed under soil and water conservation (SWC) in Kenya. These activities are categorized into water conservation, harvesting, and management techniques (Mutunga 2001). For this analysis, we will use water conservation to cover all activities that promote efficient or economical management of available surface and subsurface water resources. Indigenous communities had their own small-scale methods of water conservation but these methods are not currently viable due to population increase and land subdivision that have increased the number of water users, water pollution, and obstructed access to water bodies. Therefore, donors and other water stakeholders advocate for communal projects such as water pans, rock catchments, subsurface (sand) dams, and spring protection so that more users are able to access safe water at the community level. Implementing such a project requires a governance structure that will facilitate multi-level interaction across various organizations (public, private, and civic) and actors (informal and formal) to formulate policies and legislations to access funds and give ownership of the constructed water source to the community. However, identifying diverse stakeholders to constitute a rural water governance committee is not such a straightforward process (Prell et al. 2010). This is because actors seeking to be enjoined to local resource governance networks to implement their adaptation and mitigation projects under the climate agenda have increased. Consequently, rural water governance structures must formulate ways to integrate these additional actors for effective knowledge transfer that will build resilience and cohesion in the community.

Few published works using case studies exist on role of actors on adaptation performance in the water sector in Kenya. For example, Wamalwa (2009) studied the Mara watershed and recommended the need for a more effective coordination arrangement. Ngigi (2009) looked at climate adaptation options in water management and called for increased investment in complementary strategies that enhance adaptation by vulnerable smallholder farmers. We continue with this discourse by analyzing rural actor water networks further to answer the question “is there synergy among actors implementing the rural water conservation and adaptation agenda?” Studies based on social relational theory are increasing due to the discovery of the role of social relationships in shaping environmental outcomes, and this study is no exception as we employ social network analysis to evaluate actor linkage and their water conservation and adaptation activities in the rural community of Loitoktok.

2 Key Issues

2.1 Climate Change Impacts and Water Supply

Climate change influences virtually every element of the global hydrological cycle through changes in precipitation, evaporation, and snowmelt, to threaten global and regional water security (WBGU 2008). Schewe et al. (2013) state “Depending on the rates of both population change and global warming, the level of water scarcity may be amplified by up to 100 % owing to climate change in some regions. This means 5–20 % of the global population is likely exposed to absolute water scarcity at 2 °C of global warming”. Already many African countries experience physical water scarcity defined as a state of having less than 1,000 m^3 per capita per annum or suffer water stress defined as a state with less than 1,700 m^3 per capita per annum (Adger et al. 2007; Ngigi 2009; WBGU 2008). Subsequently, climate change impacts like; drought, heat waves, accelerated glacier retreat and hurricane intensity initiate climatic trends not previously experienced will increase future water stress (Adger et al. 2007).

In Kenya, long-term climatic analysis (1976–2000) of the ASAL region of Loitoktok in Kenya revealed a dramatic increase in the mean daily maximum temperature than did daily minimum (0.2775 °C vs. 0.071 °C per annum) especially during months with higher average maximum temperatures such as February and March but with no long-term trend (Altmann et al. 2002). This is majorly attributed to the continual landscape changes and transformation of the landscape surrounding Kilimanjaro into agricultural land that contribute regional forcing to the climatic conditions (Thompson et al. 2009). Such large-scale changes in landscape patterns have effects on regulating ecosystem services of carbon storage (global warming) and erosion control (percolation of rainfall) to significantly affect water security through temperature and rainfall behavior (Millennium Ecosystem Assessment 2005). Thus following consecutive years of major droughts, i.e., 1984, 1992, 1997, 2001/2002, 2006, 2009, and 2011, the climate change discourse in Kenya has adopted drought as the priority problem. This is because the recurrent drought episodes (Altmann et al. 2002) have dried up many water bodies and become the driving force behind migratory movements of people especially in the arid and semi-arid regions of Kenya. Impacts of natural disasters such as floods, landslides and wind storms destroy the water infrastructure and disrupt water supply in urban centres (Government of Kenya 2009b). Besides, the water crisis in Kenya is further exacerbated by water-related health problems (Government of Kenya 2009b), particularly diarrhoea and cholera in heavily populated informal settlements.

3 Adaptation Strategies in the Water Sector

There are no quick fixes for water scarcity except negotiated, proactive strategies that are economically feasible and sustainable, collectively termed as adaptation (Ngigi 2009). These strategies involve making adjustments in social and environmental processes in response to or in anticipation of climate change, to reduce potential damages or to realize new opportunities (Adger et al. 2007). According to UNECE (2009), a successful water conservation and adaptation strategy should be based on five pillars that address all stages of climate-based water crisis. These pillars are discussed below using appropriate activities implemented in Kenya.

- *Prevention* measures are long-term actions taken to avert negative effects of climate variability on water resources. For example, afforestation of the Mau Forest complex to re-establish previous flow of the Mara and Sondu rivers, timely relocation warning for Budalangi community members to avoid destruction of property and loss of lives during the annual floods season, and creation of Lake Naivasha Management Committee to promote sustainable use of the wetland.
- Measures to *improve resilience* aim to reduce negative effects of climate change on water resources. For example, livelihood diversification is clearly seen in pastoralists who have embraced crop farming using drought resistant crops to improve their incomes and living standards.
- *Preparation* measures decrease negative effects of extreme events on water resources. These include water storage, which is a prevalent activity in many Kenyan households. The government is still trying to institute an effective early warning system.

- *Response* measures alleviate direct effects of extreme events. These include evacuation, safe drinking water, and sanitation facilities inside or outside affected areas during extreme events. In Kenya, these actions are covered by non-governmental organizations such as Red Cross in coordination with government agencies during droughts or floods.
- *Recovery* measures seek to restore (but not necessarily back to the original state) economic, societal, and natural water systems after an extreme event. These include reconstruction of infrastructure especially water pipes following floods or landslides and introduction of insurance packages by Equity Bank Ltd. to act as a risk transfer mechanism.

If the five adaptation measures are incorporated into a single water governance plan, then adapting to climate variability will make economic sense because development priorities such as infrastructure quality and settlement plans will be included. However, identification and subsequent collaboration of diverse individuals with conservation knowledge and technical skills become the biggest hurdle to achieving water security in the community.

4 Integrated Water Resource Management

Traditional water management schemes concentrated on increasing water supply to growing populations (Adger et al. 2007) but poor translation of policy into strategic interventions to enhance water supply to the poor, marginalized, and rural communities created the need for new effective governance schemes. This is because studies on water governance indicate that poor management of water resources largely contributes to water scarcity in Africa. There are two such scarcity types:

- Economic water scarcity in hydrologically rich regions caused by
  - Unaffordability of water by the community when water prices are too high in relation to their incomes.
  - Nonexistent political-will causing lack of money, manpower, and other resources required for developing, allocating, transporting, and purifying water in a region (Ward and Michelsen 2002).
- Ecological water scarcity occurs when withdrawal of water resources for human use is so great that it threatens the integrity of ecosystems, and people who depend on the services of these ecosystems suffer damage (Smakhtin et al. 2004).

The need to reform water management has culminated in the formulation and implementation of the integrated water resource management (IWRM) approach in many African countries. In practice, the central government through the Ministry of Water (MoW) devolves power to regional and local administrative actors or institutions at lower levels (Ribot 2002). This strategy is founded on the decentralization principle that assumes sub-national governments are more apt at identifying water needs at rural levels and are well placed to respond to them and can be held accountable by the resident population (Smoke 2003; Wily and Dewees 2001). There are varied forms of decentralization such as political, administrative, fiscal, and institutional. Of concern to this study is institutional decentralization that is endorsed by the Kenyan IWRM. This form of decentralization denotes creation of mechanisms that devolve power from formal government bodies to other local and intergovernmental actors—traditional local authorities, non-governmental organizations, private sector partners, etc—in promoting development (Smoke 2003).

Born and Sonzogni (1995) divide the term "integration" into four aspects, namely comprehensive, interconnective, strategic, and coordinative, for successful water governance. In summary, the *comprehensive* feature involves consideration of critical biological, chemical, and human aspects for a detailed understanding and resolution of the problem. The *strategic/operational* feature identifies key goals to direct attention for ease of planning and achievement. The *interactive/coordinative* component entails informed negotiation and bargaining among parties in an interorganizational dimension, while the *interconnective* feature lays emphasis on the interrelationships among multiple resource users within the watershed. This integrative approach is seen as a solution, due to failure by traditional approaches to handle complex water resources challenges (Wamalwa 2009).

5 Social Network Analysis

Growing literature on governance focus on understanding power structures and institutions—how they develop, how they adapt to meet new challenges, and how they impact decision making at different levels of society (UNEP 2005). Thus, studying social networks of water governance can reveal deficiencies in existing water management that can be used to align water management explicitly to future challenges. Social network analysis is an approach that analyses relationships among various social actors as real interactions with local potentials and liabilities that influence success of any decision-making process (Lourenço et al. 2004). Guided by network theory, we have selected two measures of a social network to quantify patterns of interactions and indicate level of synergy among actors involved in water conservation and adaptation implementation.

5.1 Structural Holes

Structural holes are "empty spaces in social structure" that exist between two actors when either party is unaware of value available if they were to coordinate on some point (Burt 2011). There are various ways of measuring structural holes including, bridge counts, constraint values, hierarchy, and ego betweenness. Since we are analyzing information flow and actors with highest influence in the community, we use ego betweenness that examines the extent to which an actor is between other actors in the network (Everett and Borgatti 2005). The equation for calculating ego betweenness (C_B) is given below (Burt 2008; Prell 2012).

$$C_{\mathrm{B}}(k) = \sum_{i \neq j \neq k} \frac{\partial_{ikj}}{\partial_{ij}}$$

where

$\partial_{ikj}$is the number of paths linking actors i and j that pass through actor k
$\partial_{ij}$is the number of paths linking actor i and j.

Having a high ego betweenness value is highly correlated with having many structural holes that subsequently gives potential information control to principal actors. Simply put, structural holes give competitive advantage to actors whose relationships span the holes as they gain the ability to "broker" information to other actors and thereby influence the level of collective knowledge in the community. Thus, few structural holes indicate a well-connected network with high information flow that could be beneficial for increasing adaptive capacity and community resilience. However, an ideal network not only has fewer structural holes but also must have actors with links across sectors and power levels. This is because structural holes measurement also infers to the quality of information circulating in a network as connections among similar actors assume high circulation of redundant information. Conversely, diversity of actors connected in a network suggests high quality of information that facilitates spread of new ideas and behaviors in the community.

5.2 *Density*

Network density is the average strength of connection between contacts (Burt 2008). It is an indicator of how actors are linked together (Prell 2012). The density (d_i) formula below calculates the proportion of ties present in a network and helps to understand the community behavior, attitudes, and performance.

$$d_i = \frac{L}{n(n-1)/2}$$

where

n is the number of actors connected to actor i
L is the number of lines between the actors.

Density scores indicate levels of cohesion among actors because the higher the density, the higher number of ties between actors based on the assumption of close communication in the community. For example, poor adaptation project implementation may be due to fragmentation in the community that can be solved by applying social network analysis to identify where to deliberately create the missing links.

6 Analytical Framework

Presence of diverse actors in a single network implementing water conservation activities increases adaptive capacity of the entire community. Therefore, we posit that synergy will enhance coordination among actors towards achieving strategic goals for comprehensive water security in the community. This study uses the social relational approach centered on quantitative social network analysis to investigate how patterns of social relations among actors enable and constrain actors and processes in Kenya. Figure 1 illustrates the interaction between the identified key issues in water governance: climate change impacts, adaptation measures, governance aspects, and social network characteristics. Climatic change is a major challenge to water security together with demographic, economic, environmental, social, and technological forces in Africa. Secondly, the dynamism of water resources requires diverse actors to cope with anticipated changes and enhance governance. For example, unpredictable rainfall patterns in a poorly governed rural area with people having low adaptive capacity will not only experience physical shortage of water but also will practice activities that pollute surface water and in the long run reduce their ground water levels. Consequently, analysis of the water network will diagnose the problem in such a community linkage that could either be poor *representation* (structural holes) by diverse actors and *low participation* (network density) of stakeholders in decision making.

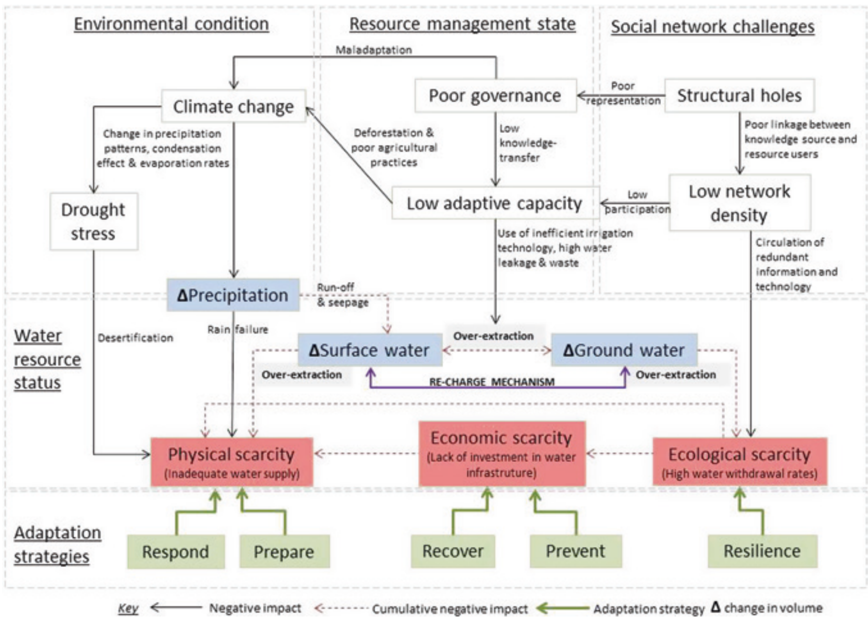

Fig. 1 Analytical framework that combines climate change, water governance, social network concepts, and five pillars of adaptation for enhanced water security

The solution to these two network structural problems is to identify *brokers* who are actors with the highest ability of bringing together a range of actors from different sectors (formal and informal) and power levels (Ernstson et al. 2010). By bridging two unconnected alters, an actor becomes capable of filtering and acquiring diverse information so that they transfer accurate and timely information through the network. Such actors seal structural holes and enhance ability of the community to respond effectively to water security issues. Thus, identification of brokers with accurate knowledge about the five pillars of water adaptation strategies and high actor linkage will equip the entire community with information to address the three types of water scarcity and promote capacity building for long-term water security.

7 Institutional Framework for Water Governance in Kenya

Kenya's water reforms initiated a paradigm shift from a narrow and sectorial approach to collaborative and multi-institutional approach in watershed management. This process structure was enshrined in the Water Act of 2002, which provides the legal framework for establishing new institutions at the national and community level, described below (Fig. 2).

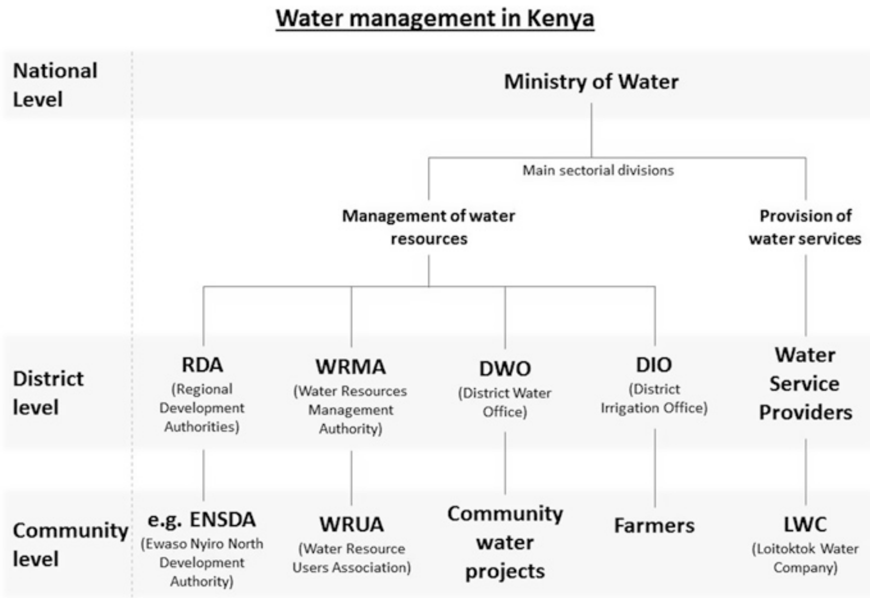

Fig. 2 Hierarchical arrangement of institutions involved in water governance in Kenya

7.1 National and Regional Level

The main institution in charge of water issues in Kenya is the MoW. Decentralization introduced other institutions such as Water Services Trust Fund (WSTF), the Water Resources Management Authority (WRMA) and departments like Water Services Board (WSB), and Water Resource Management, Irrigation and Drainage and Land Reclamation that have separate mandates within the water sector (UNDP and SIWI 2007). The government had previously established several regional development authorities to ensure equitable development through implementation of integrated programs and projects. Six institutions are charged with implementation of sustainable development within the ecosystems of major rivers and the coastline of Kenya, namely: Tana-Athi Regional Development Authority (TARDA), Kerio Valley Development Authority (KVDA), Lake Victoria Basin Development Authority (LBDA), Ewaso Nyiro North Development Authority (ENNDA), Ewaso Nyiro South Development Authority (ENSDA), and Coastal Development Authority (CDA). Their main objective is to complement the MoW projects and programs in water resource management. This chapter will focus on ENSDA established in 1989 by the Act of Parliament, Chapter 447 of the laws of Kenya and started operations in 1991.

7.2 Community Level

The Water Act also enables aggregation of individuals, water project, company, or organization that impacts or benefits from a particular water resource into a Water Resource Users Association (WRUA). This group is directly managed by WRMA through regular training on water governance and financial support for water resource development. Other stakeholders involved in water governance at the community level include, non-governmental organizations (NGOs), interest groups such as water-sellers, and other types of civil society organizations. These peripheral actors are especially important in remote and informal settlements during emergency relief, provision of community managed water supply, and construction of local boreholes, wells, or water pans (UNDP and SIWI 2007).

Decentralization is commonly treated as an unambiguously desirable phenomenon that can alleviate many problems of the public sector or sometimes as an invariably destructive force that frustrates effective government (Smoke 2003). The latter is of concern to this study since water governance faces unique difficulties due to the diverse uses of water and the important functions it performs in a given locality. Furthermore, water management has traditionally focused on specific factors directed more toward individual concerns such as water pollution control, water supply, and allocation, and specific targeted water-use sectors, rather than considering them collectively (UNECE 2009). Thus, understanding how and what to devolve in water management is a key factor for achieving water security especially under unreliable climate conditions.

8 Case Evidence on Water Adaptation Practices Under the IWRM Strategy

This case study is based on Lake Amboseli Internal Drainage Basin located in Loitoktok district in southern Kenya (Fig. 3). Loitoktok has two key rainfall seasons in the area, i.e., heavy rains in October to December and light rains in March to May. In addition, the area hydrologically benefits from the presence of Mount Kilimanjaro in two ways. First, evapotranspiration and condensing capacity of montane forests on the mountain add up to 10–25 % of the total annual rainfall (Grossmann 2008). This contribution results in uneven rainfall distribution in Loitoktok whereby the lowest elevation receives about 500 mm while the mountain slopes record an average of 1,250 mm (Government of Kenya 2009a). Similarly, temperature varies with altitude from as low as 10 °C on the eastern slopes of Mt. Kilimanjaro to a mean maximum of about 30 °C around Lake Amboseli. Secondly, the Amboseli basin also receives both surface runoff and groundwater (recharged at the forest zone between 1,500 and 3,000 m above sea level) from Mount Kilimanjaro (Grossmann 2008). Since precipitation is not enough to support the growing agricultural sector and emerging economic development in the case area, stakeholders have constructed 9 major irrigation schemes, 20 small-scale irrigation projects, 5 water system projects, 3 community water pans, 25 boreholes, 5 urban piped water schemes, and 300 shallow wells to increase local water supply (Government of Kenya 2009a). Loitoktok also supplies water through the 100-km-long old railway pipeline that transmits 17 L/s and the 262-km-long Noolturesh pipeline that transmits 200 L/s to other nearby towns

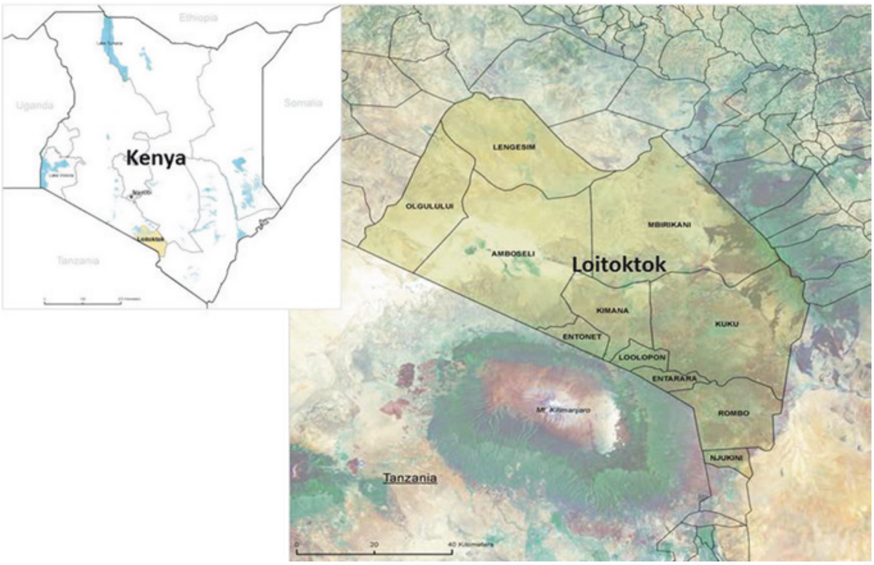

Fig. 3 Geographical location and administrative units of the study area in Kenya

such as Kajiado, Machakos, and Athi River (Grossmann 2008). Demand for water in Loitoktok district is growing rapidly due to accelerated land subdivision that is also complicating water allocation strategy between human consumption, livestock, wildlife, irrigation, and infrastructure construction.

8.1 Loitoktok Water Governance Actors

Figure 4 gives a sociogram of how actors are connected to each other while implementing different activities within the water sector in Loitoktok. A link between two actors constituted of their interaction in three activities—financial support, research and technology development, and/or project implementation in water governance at Loitoktok. To make the network more understandable, the actors were categorized according to their type and the number of structural holes for each actor was used to determine the size of the actors.

- Public actors
  Five government agencies manage the water resources in Loitoktok district, namely
  - District Water Office (DWO)—deals with domestic water data and is concerned with management of Rombo and Galeren rivers.
  - District Irrigation Office (DIO)—deals with all irrigation issues in the district together with the District Agricultural Office (DAO).
  - Water Resource Management Authority (WRMA)—responsible for protection of water sources, i.e., the Noolturesh River; administers water resource regulation, e.g., permits for water extraction and discharge and training of WRUAs.
  - Noolturesh Loitoktok Water Company (LWC)—provides piped water to urban centers in Loitoktok, i.e., Kimana, Loitoktok, and Isara. It is also commercially developing Gama springs and Kikelewa Springs
  - Ewaso Nyiro South Development Authority (ENSDA)—deals with protection and rehabilitation of Itila natural springs in the area.

  Other government agencies involved in water management are Kenya Wildlife Service (DKWS) for resolving wildlife conflicts and Kenya Forest Service (DKFS) for managing the water catchment forest zone at the slopes of Mt. Kilimanjaro.
- Private actors
  These are foreign government or international organization actors that usually collaborate with the Kenyan government. They are as follows:
  - Red Cross is responsible for establishing a canal lining project to reduce loss of irrigation water,
  - AMREF (African Medical and Research Foundation) carries out excavation of shallow wells for rain storage and conducts training on clean water and sanitation,

– SNV (Netherlands Development Organization) is involved in water provision,
– United Nations Children's Fund (UNICEF) conducts the water, sanitation, and hygiene (WASH) programs in the community.

- Non-governmental actors (NGOs)
  These actors work to increase water provision, distribution, and building capacity in the district. The non-governmental organizations that are well established in the community are Lewet-Kenya, Noomayianat, and Nia.
- Civic actors
  The civic actors comprise of 66 water project groups that are registered by the District Social Development Office (DSdO) and several business groups that are licensed by Local Government (DLG) to sell water to the community. Loitoktok has two groups of WRUA that are funded and regularly trained by WRMA in water management and resolution of water conflicts.

8.2 Loitoktok Social Network Analysis Results

The social network data was analyzed for density, structural holes, and suitable brokers. The network has a density of 0.13 confirming low linkage between stakeholders involved in water governance. The actor with the highest linkage "power" in the network is DWO who is 55 % linked to the rest of the stakeholders (Fig. 4). In terms of structural holes, DWO has an ego betweenness value of 109, DLG

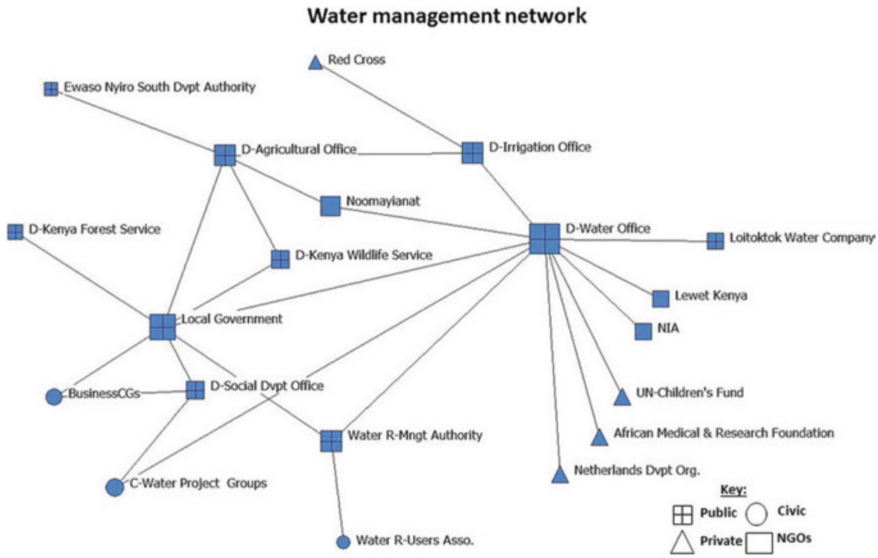

Fig. 4 Sociogram of water governance actors at Loitoktok

has 37, DAO has 18, WRMA 4 while water project groups and Noomayianat each have 2, and the rest of the actors have zero values. This means that an actor like DKWS with an ego betweenness value of 0 and an ego density of 1 is fully connected to his neighbors and thus assumedly could be implementing and sharing redundant governance information. Secondly, incomplete linkage among the Loitoktok actors has created many structural holes that hinder new information introduction and contribute to poor community representation in the network. Consequently, potential knowledge brokers in the network are DWO, DLG, DAO, WRMA, and Noomayianat that can be able to bridge these “information holes” for enhanced resource governance in the community.

8.3 Water Conservation and Adaptation Activities

Figure 5 gives the measures that are implemented by stakeholders to enhance water security in Loitoktok. Dominant activities include rain water harvest at individual homesteads and construction of water pans in communal areas for livestock and wildlife. The private actors promoted improved sanitation and hygiene practices as a way of reducing waterborne diseases. UNICEF, SNV and Red Cross, and smaller community-based organizations also initiate leadership interventions for increased collective actions in water infrastructure. Most of the technical knowledge on water harvesting and efficient irrigation came from the government agencies. This good performance in water conservation clearly indicates that the Loitoktok community is equipped with the technical know-how and knowledge in water governance but the question remains are they integrated actions?

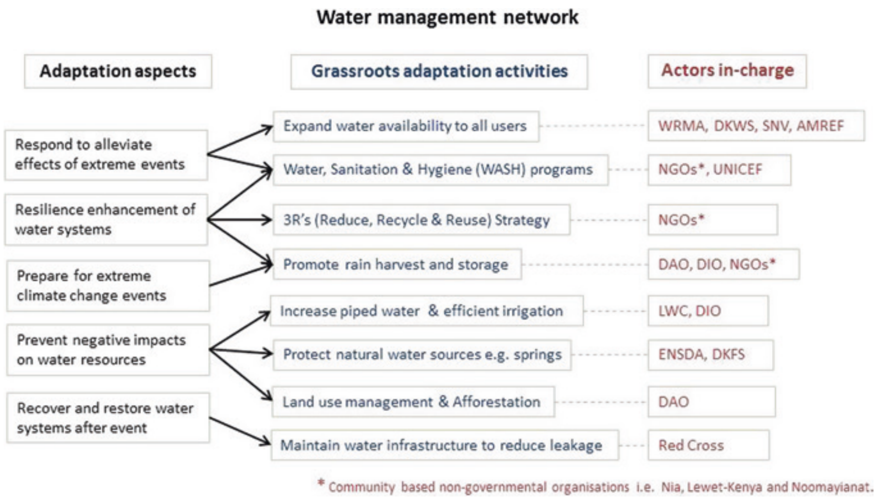

Fig. 5 Implemented adaptation activities and the respective actors in Loitoktok

The policy framework of IWRM facilitates diversity of actors to work in a single location to enhance water security for effective resource management. We use Born and Sonzogni (1995) definition to critique the level of integration in water management in Loitoktok district. First, the IWRM has a *comprehensive* aspect because the implemented measures encompass the five adaptation pillars for continuous water security. Secondly, the scheme is *strategic* in its operation because the implemented activities target-specific water issues (source, resource and user) that contribute to local water security. However, the integrated strategy fails to aid interconnective and coordinative actions among the actors resulting in independent implementation of water conservation and adaptation measures. This setback becomes a hindrance to building adaptive capacity and resilience in the community.

The analysis answers the research question by revealing lack of synergy among rural actors involved in IWRM. Though water conservation and adaptation activities are being implemented in the district, they are done in an independent manner that reduces coverage and access in the entire community.

9 Conclusion

Including concepts of social network theory in investigating rural water governance allows this chapter to contribute to the adaptation discourse through revealing weakness in decentralization that affect uptake of adaptation measures in rural communities. It is apparent from the study that IWRM in Kenya displays significant decentralization in institutional arrangements. However, effectiveness of the decentralized structures in pushing the climate adaptation agenda leaves much room for improvement. The case study of Loitoktok confirms that diverse actors have implemented solutions to the three factors instigating water security in the district namely, insufficient water supply, long distance to water points, and encroachment of water catchment areas. These solutions revolve around water storage, effective irrigation, water-point protection, and building capacity on improved sanitation and hygiene practices. However, this implementation is done independently due to lack of synergy in the Loitoktok IWRM strategy. This has resulted in small-scale gains in securing water for the region.

At the national level, there is need for alignment between national development objectives and rural strategy plans because as population increases and more urban centers are constructed then competition for water for the domestic, agriculture, and industrial sectors will intensify. Early planning and participatory technology development to develop and implement simple cost-effective water conservation measures can safeguard against future water crisis. Finally, we call for an IWRM plan that expedites linkage among local stakeholders to upscale existing adaptation measures. Such actions will strengthen rural water security, reduce resource conflicts, foster cooperative solutions, and even open opportunities for livelihood diversification.

Acknowledgments Research for this article was funded in parts by the German Science Foundation (DFG) through the Cluster of Excellence CliSAP (EXC177), Deutscher Akademischer Austauschdienst (DAAD), National Council for Science and Technology-Kenya (NCST) and Centre for a Sustainable University-Hamburg.

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